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PB-260 262

SOLID WASTE REDUCTION/SALVAGE PLANT AN INTERIM REPORT-CITY OF MADISON PILOT PLANT DEMONSTRATION PROJECT, JUNE 14 TO DECEMBER 31, 1967

NATIONAL CENTER FOR URBAN AND INDUSTRIAL HEALTH, CINCINNATI, OHIO

1968

PB 260 262

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SPRINGFIELD, VA. 22161

BIBLIOGRAPHIC DATA SHEET	1. Report No.	2.	3. Recipient's Accession No. PB-260 262
4. Title and Subtitle Solid Waste Reduction/Salvage Plant. An Interim Report City of Madison Pilot Plant Demonstration Project, June 14 to December 31, 1967			5. Report Date 1968 6.
7. Author(s)			8. Performing Organization Rept. No.
9. Performing Organization Name and Address National Center for Urban and Industrial Health, Cincinnati, Ohio			10. Project/Task/Work Unit No. 11. Contract/Grant No. PHS-UI-00004
12. Sponsoring Organization Name and Address			13. Type of Report & Period Covered 14.

15. Supplementary Notes

16. Abstracts

The progress of an economic study of the Gondard Processing of milling solid wastes as a means of reducing volume for the purpose of extending the life of a landfill is provided. A chronological review of major project events including construction and start of the mill and collection and milling of combined refuse is given. Problems, corrections, and areas of further study are evaluated.

17. Key Words and Document Analysis. 17a. Descriptors

17b. Identifiers/Open-Ended Terms

*Solid waste disposal
Refuse disposal
Sanitary landfills
*Waste processing plants
Economic analysis
Madison(Wisconsin)

17c. COSATI Field/Group 13B

18. Availability Statement	19. Security Class (This Report) UNCLASSIFIED	21. No. of Pages 40
	20. Security Class (This Page UNCLASSIFIED	22. Price $4.00 -3.00

FORM NTIS-35 (REV. 10-73) ENDORSED BY ANSI AND UNESCO. THIS FORM MAY BE REPRODUCED USCOMM-DC 8265-P74

Solid Waste Reduction/Salvage Plant,

An Interim Report

City of Madison Pilot Plant

Demonstration Project

June 14 to December 31, 1967

Prepared by City of Madison Engineering Staff,

John J. Reinhardt, and Gerard Rohlich under

Grant No. D01-UI-00004.

U.S. DEPARTMENT OF HEALTH, EDUCATION, AND WELFARE
Public Health Service
NATIONAL CENTER FOR URBAN AND INDUSTRIAL HEALTH
Solid Wastes Program
CINCINNATI
1968

This report has been reproduced exactly as received from the grantee. No editorial or other changes have been made, although a new title page, preface and abstract have been added.

Since this is an interim report of progress, the conclusions and recommendations presented should be considered as preliminary in nature, pending completion of the project and final evaluation of findings.

PREFACE

An estimated 800 million pounds of solid wastes of all types are produced in the United States every day. What to do with these solid wastes, how to dispose of them without needlessly endangering public health and welfare, and how to recover and reuse valuable materials now "thrown away" are among the most challenging and perplexing of current national problems. Because of lack of suitable planning, interest, and public understanding, these problems have reached such proportions that nationwide attention is demanded and action for the development of adequate solutions must be taken.

Intensified action concerning these problems was made possible by the Solid Waste Disposal Act, Title II of Public Law 89-272, which was signed by the President on October 20, 1965. This legislation directs the Secretary of the Department of Health, Education, and Welfare to initiate, encourage, and support a national program aimed at discovering and evaluating better methods of coping with the solid waste problem.

The Secretary is authorized (1) to conduct and support research on the nature and scope of the problem, on methods of more safely and efficiently collecting and disposing of solid wastes, and on techniques for recovering from solid wastes potentially valuable

materials and energy; (2) to provide training and financial and technical assistance to local and State agencies so that they can survey their needs in the solid waste area and plan for the development and staffing of programs capable of meeting those needs now and in the years to come; and, (3) to encourage and support projects that may demonstrate new and improved methods of solid waste collection, handling, and disposal.

To carry out these responsibilities, the Solid Wastes Program was established in the National Center for Urban and Industrial Health of the Public Health Service. Among the responsibilities with which the Program is charged is that of providing grant support for demonstrations relating to the development and application of new and improved methods of solid waste collection, storage, processing and ultimate disposal; and also for studies and investigations that may lead to a demonstration of improved disposal practices, or may provide solutions for regional or national solid waste disposal problems. Associated with this is the responsibility of collecting and making available by appropriate means the results of, and other information pertaining to, such federally supported demonstrations, studies and investigations.

Accordingly this report has been reproduced by the Public Health Service to disseminate as widely as possible the latest available

information and findings of a project that has received grant support from the Solid Wastes Program. It is hoped that it will provide those working in this field with useful information that will be of assistance in developing approaches to the solutions of their solid waste disposal problems.

This is an interim report of project progress, and additional work is currently underway to complete the project as identified in the abstract included herein. Additional progress reports, when received, will also be made available by the Public Health Service for widespread distribution and use. The final report will be issued as a Public Health Service publication.

Richard D. Vaughan

Chief, Solid Wastes Program

ABSTRACT OF DEMONSTRATION GRANT D01-UI-00004

TITLE: Solid Waste Reduction/Salvage Plant

GRANTEE: City of Madison, Wisconsin

PROJECT DIRECTOR: John J. Reinhardt, Civil Engineer III
Engineering Department
Room 115, City-County Building
Madison, Wisconsin 53709

DATE PROJECT STARTED: June 1, 1966

DATE PROJECT ENDS: May 31, 1969

OBJECTIVES: 1) To make an economic study of the Gondard Process of milling solid wastes as a means of reducing volume for the purpose of extending the life of a landfill, 2) To evaluate the sanitary aspects of milled solid wastes especially with respect to rodents, insects, odor, dust, blowing litter, and fires, 3) To determine the feasibility and sanitary aspects of using milled domestic solid wastes as collected from households, without separation, for deposit in a fill site without cover, 4) To evaluate the economic feasibility of salvaging items such as paper and metals, and 5) To investigate physical changes in the condition of milled solid wastes versus unmilled solid wastes in the fill site.

PROCEDURES: A Gondard hammer-type reduction mill will be constructed to process a portion of the solid wastes produced in the City of Madison. The first year's milling operation will be conducted in twelve separate periods, each of one month's duration, in accordance with the

following schedule: first month, combined domestic refuse; second month, domestic garbage only; third month, domestic refuse other than garbage. This sequence will be repeated three more times to permit evaluation of seasonal effects on each of the three categories of solid wastes. Milled refuse produced during each period will be placed in a separate landfill cell. The surface of each cell will be leveled by a front-end loader, and each cell will be packed occasionally by a bull-dozer.

For control purposes, sanitary landfill cells of unmilled solid wastes will be constructed. Each control cell will contain the same weight of material as is placed in the corresponding milled-refuse cell.

For one cell of each type of refuse, three different grate mesh-sizes will be used in the mill, in order that an economic analysis may be made to determine the optimum mesh-size.

The economic and technical feasibility of the milling process will be evaluated. Studies will be made to determine reduction of landfill volume requirements for milled wastes, and comparative characteristics of milled and unmilled wastes relative to settlement, leaching, gas production, and rodent, insect, odor, dust and blowing litter problems.

Following completion of the test cells, milled solid waste will be worked into the City's regular landfill operation.

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Landfill and milling operations will be conducted by employees of the City of Madison. The Civil Engineering Department of the University of Wisconsin will conduct the evaluation phase of the project, under the direction of Professor Gerard Rohlich.

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A PROGRESS REPORT ON THE

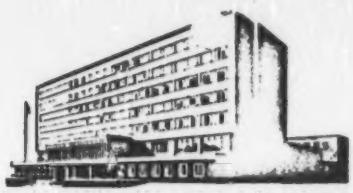
CITY OF MADISON PILOT PLANT

DEMONSTRATION PROJECT FOR MILLING REFUSE

WITH A HEIL GONDARD HAMMER MILL

JUNE 14, 1967 THROUGH DECEMBER 31, 1967

DEMONSTRATION GRANT NO. 1-D01-UI-00004-01



DONALD E. THEOBALD, City Engineer City–County Building, Madison, Wisconsin 53709

CITY OF MADISON

January 16, 1968

Mr. Steven Levy
Project Officer
Demonstration Grants Activity
National Center for Urban &
Industrial Health
222 East Central Parkway
Cincinnati, Ohio 45202

SUBJECT: Demonstration Grant No. 1-D01-U1-00004-01

Dear Mr. Levy:

Four copies of the progress report that you requested on Demonstration Grant Project 1-D01-U1-00004-01 are submitted to you with this letter. The report is not intended for the presentation of conclusions on the practice of milling refuse for landfill disposal, but to provide a project progress report and to present some preliminary findings and problems that have been experienced between the time the mill was started up in June, 1967 and December 31, 1967.

The preliminary cost figures presented in this report for milling refuse are extremely high and are given only to indicate what the costs are at this early stage of the project. It is my understanding that this report will be condensed for use in a Department of Health, Education & Welfare publication summarizing many projects. It is suggested that any summary of the cost data taken from this report clearly indicate that the data is incomplete and of a preliminary nature. If the cost data is used without the many qualifications contained in the report, it would be very misleading.

Yours very truly,

John J. Reinhardt

John J. Reinhardt
Project Director

JJR:lh
Enc.
cc: Mr. William Kerr, Department of Health, Education & Welfare, Region V
Mr. Harvey E. Wirth, State of Wisconsin, State Board of Health
Mr. Avery Wells, State of Wisconsin, Division of Resource Development
Mr. Gerard Rohlich, University of Wisconsin
Mr. Arnold Meyer, Heil Co.
Mr. Edwin Duszynski, Director of Public Works

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FORWARD

The following progress report on Demonstration Project 1-D01-UI-00004-01 has been divided into two parts.

Part one of the report is written from the standpoint of a municipality starting up and attempting to operate a refuse reduction mill.

Part two of the report is intended to cover the evaluation of the project by the University of Wisconsin thru November 20, 1967. It contains a short summary of: The instrumentation work performed by the University of Wisconsin, to gather data for evaluating the objects of the Demonstration Project contained in the appendix of this report; and a preliminary evaluation of the first nine weeks data obtained while milling combined refuse.

PART I

A PROGRESS REPORT ON THE

MILL START UP AND MILLING EXPERIENCES

JUNE 14, 1967 THROUGH DECEMBER 31, 1967

CHRONOLOGICAL REVIEW OF MAJOR PROJECT EVENTS

I - The construction of the mill was substantially completed and start up operations were begun on June 14, 1967.

II - A combined refuse (garbage and rubbish) collection was instituted in approximately one half of Madison on September 11, 1967 to obtain combined refuse for the project. At the same time as the combined collection was instituted, large and odd sized items such as over stuffed chairs, swing sets, and bicycle frames, which were found to cause material handling problems during start up operations, were eliminated from the regular packer truck collections. Open route trucks, which had formerly been used to pick up items too large to fit into a packer truck, were assigned to pick up all large and odd sized articles not easily handled at the mill.

III - On September 18, 1967, milling of combined refuse for evaluating the project was begun. The following Table I contains a summary of the type and amount of material contained in each cell built for project evaluation from September 18, 1967, when project evaluation began, to December 31, 1967.

TABLE I

SUMMARY OF TONS MILLED DURING

MILL START-UP AND CELL CONSTRUCTION

JUNE 14, 1967 THROUGH DECEMBER 31, 1967

CELL NO. OR DESCRIPTION	DESCRIPTION	DATES START-FINSIH	GRATE SIZE	TONS MILLED	TONS UNMILLED
Start Up Mill	R[1]	6-14 - 9-17	55 mm & 100 mm	670	-----
1	CR[2]	9-18 - 10-6	100 mm	534	-----
2	CR	10-9 - 10-27	55 mm	450	-----
3	CR	10-30 - 11-17	150 mm	703	-----
4A	CR	9-18 - 10-18	------	---	1045
4B	CR	10-20 - 11-17	------	---	683
5	G[3]	11-20 - 12-1	150 mm	103	-----
6	G	12-4 - 12-8	------	---	38
7	R	11-27 - 12-8	150 mm	310	-----
9	CR	12-11 - 12-29	150	474	-----.

TOTAL TONS MILLED IN START-UP OPERATIONS (PLACED IN ONE LARGE PILE) 670 TONS

TOTAL TONS MILLED FOR CELLS 2564 TONS

TOTAL TONS MILLED JUNE 17, 1967 THROUGH DECEMBER 31, 1967 3234 TONS

1. R - Residential Refuse Without Garbage (Rubbish)

2. GR - Residential Combined Refuse - Rubbish and Garbage

3. G - Drain Wrapped Garbage

START UP PROBLEMS AND CORRECTIONS

I - The first start up problem encountered was frequent jamming at the point where the refuse was transferred from the bin conveyor (see Appendix for plant layout) to the transverse conveyor, and from the transverse conveyor

to the elevating conveyor. This problem was felt to be caused by the slightly sloping heavy gage sheet metal conveyor sides at the transfer points, the covers provided on all the belt conveyors, and the many long and oversized items picked up with residential collection. The jamming was greatly reduced by making all sloping sheet metal sides at the transfer points vertical and removing the conveyor covers. The elimination of oversized and odd shaped items from the collections has reduced the jamming at the transfer points to an insignificant problem.

II. As previously mentioned, oversized and odd shaped items that were collected in packer trucks at the time the mill was started up caused feed troubles in the conveyors. The elimination of these items from the packer truck collection solved most of this problem. However, over or odd sized articles still enter the packer trucks when the collection crews are careless. The minimal sorting that is done at the mill usually involves an item that should not have been placed in a packer truck.

III. The number and height of cleats on the metal belt of the bin conveyor, which pull the material out of the main receiving bin, required increasing to increase the feed of material from the bin conveyor.

IV. The bin conveyor drive was under powered at high speeds. A larger motor was placed on the drive and the drive was modified to provide more power to the bin conveyor belt.

V. A number of modifi ations were made to the Gondard hammer mill to provide quicker access to the hammers and to require less labor and time to change the hammers.

VI. The two largest problems encountered with the Gondard mill itself were that the 150 H.P. mill motor over heated and the mill was frequently stopped by large loads during the initial start up period. The motor overheating

problem was solved by providing larger heaters for the motor. The frequent overloading of the mill was found to be due to slow response of the original automatic controls. The problem was corrected by modifying the automatic controls and also allowing hand stopping of the feed belts when an overload on the mill occurred. The modifications permitted the mill hammers to regain momentum before the next load was allowed to drop into the mill.

It was also learned through experience that optimum production was obtained when the mill operator visually monitored the feed into the mill and manually by-passed the automatic controls when, in his judgment, the load on the mill should be increased or decreased.

EXISTING PROBLEMS AND IMPROVEMENTS UNDERSTUDY

I. The present Heil load lugger and bin system for conveying the milled refuse from the mill to the landfill has proved inadequate. During periods of high production, the material can be milled faster than the load lugger system can haul the milled material away. The present system also requires two men for the final disposal of the milled material.

Two used Leach packer trucks are presently being readied for use as an interim solution to the problem. Preliminary experiments with other packer trucks suggests that the use of packer trucks for final disposal has some merit. Densities of as high as 1000 pounds per cubic yard can be obtained in the packer trucks, versus about 400 pounds per cubic yard in the Heil Load Lugger bins. The large capacity of the packer body and the high densities obtained with the packing mechanism hopefully should reduce the manpower requirements for final handling to one man.

Pneumatic conveyance of the milled material is thought to hold more potential for a long range solution of the final handling problem than the packer trucks. Initial trials with a Vac-All machine showed that the milled

material can be easily pneumatically conveyed into a truck body. While the unit densities of the pneumatically conveyed material in the receiving vehicle were not high in the initial tests, the pneumatic loading of the milled refuse into final conveyance vehicles is being investigated further because of the flexibility the pneumatic system appears to offer.

II. A dust problem is caused by dumping refuse into the bin conveyor, and also by dust coming out of the Gondard rejection tower and feed opening.

The use of water sprays has reduced, but not eliminated, the dust problem when dust is dumped into the bin conveyor. It may be necessary to partition the mill to completely solve the dust problem.

III. The daily production rate is extremely low at times because the mill runs out of refuse. Several adjustments to the hours of mill operation and the collection schedules have reduced this problem. The scheduling of the collection and the plant operations to compliment each other has not proved as easy as originally anticipated. Additional study and schedule adjustment will be necessary to completely solve the problem of providing a sufficient supply of refuse to the mill at all times.

OBSERVATIONS AND CONCLUSIONS

I. Hourly production rates to date, have been somewhat lower than were expected from reading European trade journal reports on milling refuse. It is felt part of this is due to the difference between American and European refuse. Apparently, European refuse contains larger amounts of ash and putrescible matter. Recent information received from the Greater London Council of England provided by Mr. P. K. Patrick, who has written a very informative paper on the European method of milling refuse, indicates that approximately 20% of the refuse in the Greater London areas consists of garbage and approximately 20% is ash and clinkers. The City of Madison records shown that only about 10% of refuse collected is garbage

and little or no ash is produced as a large part of the City uses natural gas or oil for heating fuels. Experience shows that a large part of the material being milled at Madison is paper and cardboard boxes.

II. Preliminary experience shows a slight difference between the production rates with the 55 mm grate and the 100 mm grate and a noticeable difference between the production rates with a 100 mm grates and the 150 mm grates. It will require another several runs on each grate size to establish if the difference in production rates was definitely due to increasing the opening in the grate, or whether it was due to a seasonal variation.

III. The design of the plant leaves much to be desired in terms of daily cleanup. An excess of spillage occurs at the point where milled refuse falls onto the discharge conveyor. All spilled milled and unmilled refuse is hosed down sloped surfaces to the lowest floor level. There is presently no efficient method of removing the material that ends up at this level.

IV. The end product from milling rubbish or combined refuse appears to be quite acceptable for landfill purposes without any cover. Milled refuse has not been covered since the milling began at the landfill site in June, 1967. The uncovered milled material has to date, produced a fill material satisfactory to the personnel of the Department of Resource Development, and the City of Madison Health Department.

V. The City of Madison personnel operating equipment on the landfill have expressed satisfactory opinions of milled material for landfill. They are expecially pleased with the ease with which the milled material can be handled with a machine. The milled refuse has also exhibited good load carrying capabilities during wet weather and has been used for road build ing purposes particularly during wet periods when soil on the site was impassable.

VI. The unmilled refuse cells produced a blizzard of paper before the cells could be covered. The cells built for refuse milled with the 55 mm and 100 mm grate, did not produce any noticeable wind blown paper, but the cells built with the 150 mm grate did contain enough large pieces of paper, that the blowing of paper could be seen. It appears that the small particles of paper produced by milling, adhere to each other when placed in a pile, and after several days, form a "skin" at the surface of the pile.

VII. No appreciable odors have been noticed from the milled refuse even though some of the milled refuse has been on the landfill uncovered since June, 1967.

VIII. No fly larvae or pupae have been found in the milled refuse to date.

IX. The amount of hand separation and sorting that has been required at the mill is far below what was originally anticipated.

X. The milling of garbage has not been considered successful from the standpoint of producing a material satisfactory for landfill without cover. The paper is ground into small particles and mixed with the putrescible content of the garbage but the resulting material has a strong odor and much of the putrescible material is easily identified.

Garbage milled early in the fall of 1967 had to be covered after several days because of the flies and odor.

A Cell of milled garbage built in December has not been covered to date. The cell is being watched closely for problems, and it is anticipated that the cell will have to be covered in the spring when the temperatures rise above freezing.

XI. Preliminary investigations into the possibilities of salvage have not been encouraging. The local salvage dealers have shown very little interest in the rejected metal or in buying paper or cardboard that has been placed in a packer collection vehicle with refuse.

SUMMARY

Milling started on June 14, 1967 and by September 17, 1967, it was felt that the mill employees had gained sufficient experience and enough of the major start-up problems had been solved to begin milling refuse for evaluation purposes.

As of December 31, 1967, rubbish, combined refuse, and garbage has been milled; a 55 mm, 100 mm, and 150 mm grate size has been used to try and determine an optimum grate size; a number of cells has been constructed and instrumented to obtain information on the characteristics of milled refuse and the suitability of milled refuse for uncovered landfill operations and market studies of salvage possibilities have been undertaken.

There appears to be little difference between milled combined refuse and milled rubbish. Milling garbage does not appear practical. The experience to date has shown that the milled combined refuse and rubbish can produce a satisfactory uncovered landfill. The experience with garbage has shown milled garbage does not produce a satisfactory material for an uncovered landfill.

Preliminary investigations into the possibilities of salvage have been discouraging as local salvage dealers have shown little interest in the rejected metal or dirty paper.

The demonstration project to date has proven that uncovered milled combined refuse or rubbish can successfully be used for landfill without causing any sanitary or aesthetic problems. At present, there is insufficient data available to attempt to project the cost of milling from a pilot plant basis to a system of mills that would mill all millable solid waste produced in the City of Madison. It is felt that the number of plant modifications and other changes that are under study for implem-

entation in the next 6 months will substantially increase production capability of the mill and reduce unit production costs.

It is hoped that by January 1, 1969, all the experimental cells will be completed. A regular landfill operation can then be undertaken to compare a milled refuse landfill operation with a regular fill and cover operation. It is felt that the present method of using small cells, for comparing landfill operations using milled refuse with landfill operations using unmilled refuse, does not show the true apparent advantages of milled refuse.

Two large problems that effect the economics of the project remain to be solved. They are:

1 - Finding a satisfactory method of handling the milled material from the mill to the landfill.

2 - Co-ordinating the milling operation with the collection operation.

It is anticipated that most major problems can be resolved by the start of the 03 project year in June, 1968.

PART II

UNIVERSITY OF WISCONSIN PROGRESS REPORT

STATUS

As of November 20, 1967, residential, combined refuse representative of the fall season has been milled. During the fall season three different grate sizes (2",4" and 6") have been used in the mill for periods of three weeks each.

The milled refuse has been placed in three uncovered cells in the field according to the grate size used. Concurrently, unmilled combined refuse was dumped in a covered control cell. Thus, various comparisons can be made between milled and unmilled refuse, and between refuse milled through grate openings of different sizes.

Equipment has been placed in the various cells so that quantitative measurements can be made. Settlementplates have been installed at the top and bottom of each cell so that settlement can be measured, and densities determined by accounting for settlement. In addition, 55 gallon drums have been buried in the cells in order to collect gas and water samples. Plastic sheets have also been laid on a slope at the bottom of the cells in order to collect additional leachate in the event that the barrels do not collect sufficient leachate for analytical purposes. Temperature-moisture probes have been placed in the cells.

In addition, visual observations have been made of the milling process and of the milled and unmilled refuse cells.

RESULTS

The following discussion of results is divided into two sections: (1) in plant results, and (2) landfill results.

IN PLANT RESULTS

Many of the results need qualification and adjustment before they could be applied to a large-scale operation. For example, the production rates listed in Tables II and III are low because the material is not being conveyed to the mill as fast as the mill can grind the material.

TABLE II

OPERATING PRODUCTION RATE[1] VS. GRATE SIZE

Production Rate-Operating Time Only Tons Per Hour	Grate Size (Opening)		
	55 mm-2 inch	100 mm -4 inch	150 mm-6 inch
Total	6.0	6.8	9.3
Milled	5.6	6.6	9.1
Rejected	0.4	0.2	0.2

TABLE III

OVERALL PRODUCTION RATE[1] VS. GRATE SIZE

Production Rate - Operating Time Plus Shutdown Time Tons per Hour	Grate Size (Opening)		
	55 mm-2 inch	100 mm-4 inch	150 mm-6 inch
Total	5.4	6.0	8.4
Milled	5.1	5.8	8.2
Rejected	0.3	0.2	0.2

1. The data presented is three week average.

A partial list of cost data for the pilot runs are listed in Table IV. Sufficient data is not yet available on maintenance, supply, and hauling costs. The essence of the following qualifications is that the listed costs are higher than would be true of a larger and differently designed plant. Some of the pertinent qualifications are as follows:

1 - Other than mechanical failure, there has been an unusual amount of time due to not having refuse in the plant, and excessive clean-up time required because of the number of conveyors.

2 - The feed rate seems to be controlling production in that the conveyors are not getting material to the mill as fast as the mill can grind.

3 - If a similar plant could be built in an area without soil problems, preferably on a hillside site, the capital cost of the plant could probably be reduced because the foundation would not need to be as extensive and at least two of the conveyors could be eliminated. In addition, some of the clean-up spots and places where conveyor jams occur could be eliminated.

4 - The method currently used to haul away milled refuse requires two people. With some modification to the system at least one person would not be needed. Thus, the labor personnel cost could be reduced.

5 - No value was listed for salvable items because none of the local scrap dealers contacted indicated an interest in the rejected metals which are mainly tin cans.

6 - The plant is located at the landfill. Thus, the hauling cost is minimal.

TABLE IV

COSTS[3] PER TON VS. GRATE SIZE

Cost	Grate Size		
	55 mm-2 inch	100 mm-4 inch	150 mm-6 inch
Labor	$ 2.98	$ 2.35	$1.83
Depreciation	3.85	3.24	2.46
Hammer Wear	0.34	0.32	0.28
Utility	0.92	0.63	0.70

3 - Using the toal production rates shown in Table II.

The following table lists the same cost categories adjusted for the excessive down time but not for plant design or extra personnel. The adjusted costs were determined by computing the tonnage which would be milled in a seven hour milling day, whereas the mill is actually, working about five and a half hours daily. Thus, as the tonnage increases, the cost per ton decreases.

TABLE V

ADJUSTED COST PER TON VS. GRATE SIZE

Cost	Grate Size		
	55 mm-2 inch	100 mm-4 inch	150 mm-6 inch
Labor	$ 2.42	$2.04	$1.50
Depreciation	3.17	2.86	2.04
Hammer Wear	0.26	0.23	0.16
Utility	0.76	0.56	0.58

Utility costs listed in Tables IV and V include gas, water, and lighting costs in addition to the cost of power for the mill. The overall utility cost increased when the 6 inch grate was used because the gas used for heating the building increased sharply due to the weather. However, the power cost for operating the mill decreased with an increase in the grate opening.

In the above two tables, the following costs were computed as listed below:

(a) Labor	Wages paid divided by tons milled during the three week period.
(b) Depreciation	The annual cost was determined by assuming various rates of depreciation, and by assuming interest rates depending on the source of the funds. The annual cost was divided by the proportioned annual tonnage milled. Land costs were not included in the depreciation cost.
(c) Hammer Wear	The cost paid for the hammers minus the estimated resale revenue was divided by the tonnage milled while using a set of hammers.
(d) Utility	Both the utility quantities used and the tonnage milled during three week periods were proportioned up to one month. The resultant utility cost was divided by the monthly tonnage milled.

LANDFILL

One of the justifications for milling refuse is that landfill space is conserved. An initial comparison indicates that the density of unmilled, residential, combined refuse compacted to a six-foot depth by a bulldozer (D-7) is about 500 pounds per cubic yard. The same refuse, milled and handled in the same way, can be compacted to a density ranging from 900 to 1100 pounds per cubic yard.

Surveying techniques are being used to determine the settlement of the cells, as well as the densities. However, there are no settlement results available at this time.

Records have been kept of the amount of time required to compact and to cover the various cells. Table VI lists the equipment time required for milled and unmilled refuse.

TABLE VI

EQUIPMENT TIME REQUIRED PER HUNDRED TONS

OF MILLED AND UNMILLED REFUSE

Time in hours Per Hundred tons	Milled - Grate Size			
	55 mm	100 mm	150 mm	Unmilled
	4.6	3.4	4.3	6.2

Records are also being kept of the amount of cover dirt used to cover the unmilled cell.

2,130 cubic yards of cover dirt were used to cover 3,680 cubic yards of refuse weighing 1,035 tons. The amount of cover dirt used is high because one foot of cover was used to cover six feet of refuse, the cell is only 160 feet wide by 160 feet long, and because in addition, to covering the surface of the cell, the face of the refuse was covered most every night.

Temperatures and moistures have been measured at the two and four-foot depths in the cells which are six feet high.

Table VII lists the temperatures and moisture contents obtained thus far.

TABLE VII

INITIAL TEMPERATURE FOR VARIOUS CELLS

	Temperature °F		Percent Moisture (Wet Weight Basis)	
Refuse Cell	2' Depth	4' Depth	2' Depth	4' Depth
Combined Refuse Milled through 100 mm Grate	110	95	----	-----
Combined Refuse Milled Through 150 mm Grate	95	----	50	20
Unmilled Combined Refuse	55	65	25	25

Another one of the field studies being made pertains to the quality and quantity of leachate and the quality of the gases coming from milled and unmilled refuse. To date, sampling equipment has been placed in the cells, but no samples have been collected.

Inspections have been made by the City Health Department regarding the sanitary characteristics of milled vs. unmilled refuse. The results were reported in a letter dated November 14, 1967 to C. K. Kincaid, M.D., Director of Public Health. In summary, the letter notes the following:

1 - There are no objectionable odors from the milled area.

2 - No evidence of fly breeding was noted in the milled area.

3 - At no time during the observations had any significant health problem developed in connection with the operation.

In general, on all except one day--no flies were noted around unmilled areas as well as milled areas. No evidence of rodents were noted on any of the survey dates. During the surveys sea gulls were primarily noted on the unmilled areas. However, on other dates various project personnel noted the sea gulls on the milled as well as unmilled areas.

ORIGINAL GRANT APPLICATION

BROAD PROJECT OBJECTIVES

1. To make an economic study of the Gondard process of milling refuse, garbage and rubbish as a means of reducing volume for the purpose of extending the life of a landfill site.

2. To evaluate the sanitary aspects of milled refuse, especially with respect to rodents, insects, odor, dust, blowing litter, and fires.

3. To determine feasibility and sanitary aspects of using milled domestic refuse as collected from households, without seperation, for deposit in a fill site without cover, as is done in a number of communities in Europe.

4. To evaluate the economic feasibility of salvaging items such as paper, and metals.

5. To investigate physical changes in the condition of milled versus unmilled refuse in the fill site during the three year demonstration period.

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55 MM GRATES - FALL, 1967 - OCTOBER 9-27, 1967

- A. Plant Performance
- B. Refuse Quantities
- C. Work Times
- D. Refuse Cells
  1. Milled Cell
  2. Unmilled Cell
- E. Utility and Equipment Usage

SUMMARY OF EXPERIMENTAL RUN - MILLED COMBINED REFUSE 21
100 MM GRATES - FALL 1967 - SEPTEMBER 18 - OCTOBER 6, 1967

- A. Plant Performance
- B. Refuse Quantities
- C. Work Times
- D. Refuse Cells
  1. Milled Cell
  2. Unmilled Cell
- E. Utility and Equipment Usage

SUMMARY OF EXPERIMENTAL RUN - MILLED COMBINED REFUSE 22
150 MM GRATES - FALL, 1967 - OCTOBER 30 - NOVEMBER 17, 1967

- A. Plant Performance
- B. Refuse Quantities
- C. Work Times
- D. Refuse Cells
  1. Milled Cell
  2. Unmilled Cell
- E. Utility and Equipment Usage

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SUMMARY OF EXPERIMENTAL RUN
MILLED COMBINED REFUSE - 55 MM GRATES - FALL, 1967
OCTOBER 9-27, 1967

Plant Performance

Tons Milled	450		
Milling Time	75.1 hours		
Down Time	7.9 hours		
Total Time	83.0 hours	Operating Rate	Overall Rate
Average Production Rates - Tons per Hour			
Milled		5.6	5.1
Rejects		0.4	0.3
Total		6.0	5.4

Refuse Quantities

Total Quantity of Combined Refuse from all Wards --Tons	1,073	
Total Milled - Tons	450	
Total Unmilled - Tons	623	
Total Large Items & Brush - considered separately - 205 Loads;	72 Tons	
Total No. of Loads of Refuse Received at Site	363	
Total No. of Loads Milled	129	
Percentage of Total Loads which are Milled	36%	

Work Times

Man-Hours of Milling - 75.1 hours x 3 men =	225.3 man-hours	
Total Man-Hours in Plant	399.5	
Man-Hours of Compaction (1 man)		
Milled - Man-Hours	20.7	
Unmilled - Man-Hours	35.9	
Total Man-Hours for Compaction Equipment Operator	124.0	

Refuse Cells

Milled Cell		
Tons	450	
Equipment Time - Hours	20.7	
Equipment Time (Hours) per Hundred Tons	4.6	
Unmilled Cell		
Tons	623	
Equipment Time - Hours	35.9	
Cover Dirt - Cubic Yards	1,180	for 402 tons
Equipment Time (Hours) per Hundred Tons	5.8	
Cover Dirt - Cubic Yards per Ton	2.9	

Utility and Equipment Usage

220 Volt Electrical Service - Kilowatt Hours	4,520
440 Volt Electrical Service - Kilowatt Hours	8,480
Gas - Hundreds of Cubic Feet	1,106
Water - Cubic Feet	4,235
Load Lugger - Miles	93
Front End Loader - Hours	8.4
Packer No. 411 - Miles	15

SUMMARY OF EXPERIMENTAL RUN
MILLED COMBINED REFUSE - 100 MM GRATES - FALL 1967
SEPTEMBER 18 - OCTOBER 6, 1967

Plant Performance

Tons Milled	534	
Milling Time	77.9 hours	
Down Time	11.4 hours	
Total Time	89.3 hours	

Average Production Rates - Tons per hour	Operating Rate	Overall Rate
Milled	6.6	5.8
Rejected	0.2	0.2
Total	6.8	6.0

Refuse Quantities

Total Quantity of Combined Refuse from all Wards--Tons	1,167	
Total Milled-Tons	534	
Total Unmilled - Tons	633	
Total Large Items & Brush - considered seperately - 257 Loads;		122 Tons
Total No. of Loads of Refuse Received at Site	346	
Total No. of Loads Milled	157	
Percentage of Total Loads which are Milled	45%	

Work Times

Man-Hours of Milling - 77.9 hours x 3 men =	234 man-hours	
Total Man-Hours in Plant	378	
Man-Hours of Compaction (1 man)		
Milled - Man-Hours	18.4	
Unmilled - Man-Hours	33.0	
Total Man-Hours for Compaction Equipment Operator	133.5	

Refuse Cells

Milled Cell		
Tons	534	
Equipment Time - Hours	18.4	
Equipment Time (Hours) per Hundred Tons	3.4	
Unmilled Cell		
Tons	633	
Equipment Time - Hours	33.0	
Cover Dirt - Cubic Yards	1,190	
Equipment Time (Hours) per Hundred Tons	5.2	
Cover Dirt - Yards per Ton	1.9	

Utility and Equipment Usage

220 Volt Electrical Service - Kilowatt Hours	6,060
440 Volt Electrical Service - Kilowatt Hours	8,160
Gas - Hundreds of Cubic Feet	135
Water - Cubic Feet	3,775
Load Lugger - Miles	241
Front End Loader - Hours	10.2

SUMMARY OF EXPERIMENTAL RUN
MILLED COMBINED REFUSE - 150 MM GRATES - FALL, 1967
OCTOBER 30, - NOVEMBER 17, 1967

Plant Performance

Tons Milled	703		
Milling Time	75.7 hours		
Down Time	7.6 hours		
Total Time	83.3 hours		
Average Production Rates - Tons per hour		Operating Rate	Overall Rate
Milled		9.1	8.2
Rejects		0.2	0.2
Total		9.3	8.4

Refuse Quantities

Total Quantity of Combined Refuse from all Wards--Tons	1,165	
Total Milled - Tons	703	
Total Unmilled - Tons	462	
Total Large Items & Brush - Considered separately - 187 Loads;		82 Tons
Total No. of Loads of Refuse Received at Site	375	
Total No. of Loads Milled	195	
Percentage of Total Loads Which Are Milled	52%	

Work Times

Man-Hours of Milling - 75.7 hours x 3 men =	227.1 man-hours	
Total Man-Hours in Plant	399.5	
Man-Hours of Compaction		
Milled Man-Hours	29.6	
Unmilled Man-Hours	35.5	
Total Man-Hours for Compaction Equipment Operator	131.5	

Refuse Cells

Milled Cell		
Tons	703	
Equipment Time - Hours	29.6	
Equipment Time (Hours) per Hundred Tons	4.2	
Unmilled Cell		
Tons	462	
Equipment Time - Hours	35.5	
Cover Dirt - Cubic Yards	1,030 for 683.20 tons	
Equipment Time (Hours) per Hundred Tons	7.7	
Cover Dirt - Cubic Yards per Ton	1.5	

Utility and Equipment Usage

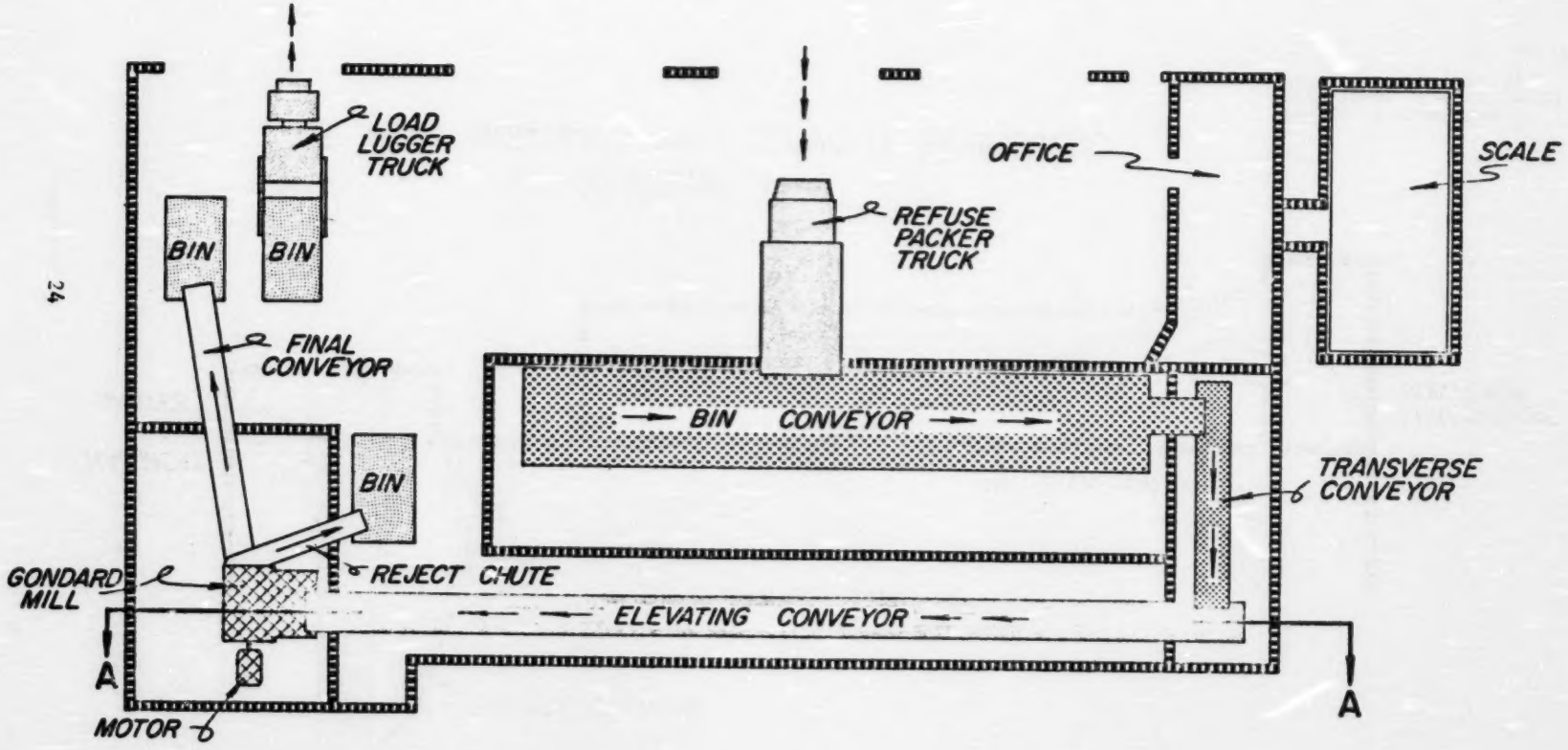
220 Volt Electrical Service - Kilowatt Hours	5,500
440 Volt Electrical Service - Kilowatt Hours	7,680
Gas - Hundreds of Cubic Feet	2,011
Water - Cubic Feet	4,000
Load Lugger - Miles	111
Front End Loader - Hours	10.2

TABLE OF LABOR WAGES

Position	Present Job	Wage Rate $/hour
Refuse Reduction Plant Operator	Operate the Plant	$ 3.90
Equipment Operator III	Operate Heavy Equipment	$ 3.40
Public Works Maintenance Man I	Assist Equipment Operator III	$ 2.64

TABLE OF DEPRECIATION DATA

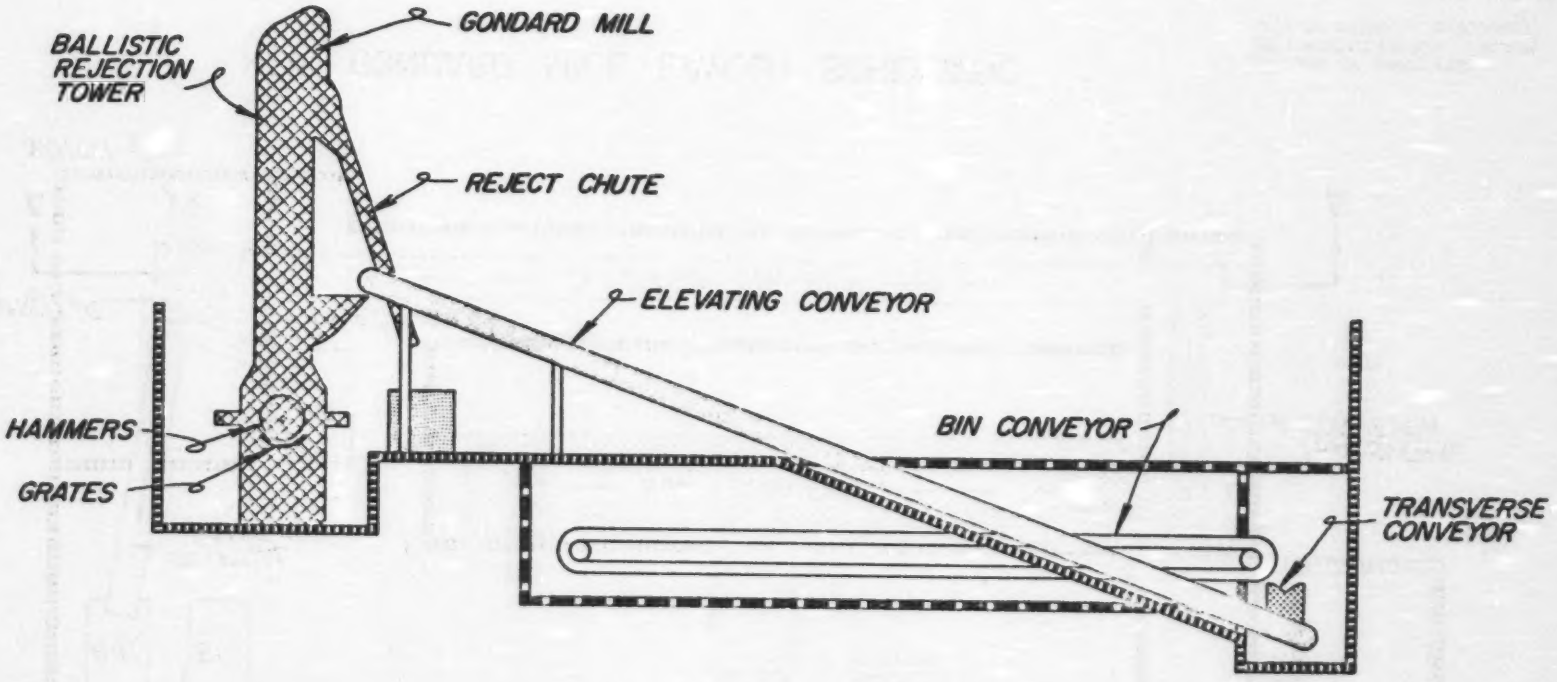
Equipment Item	Cost	Amortization Rate-Years	Interest Rate	Salvage Value
Building & Foundations	$133,000	20 years	4.2%	$4,000
Load Lugger	$ 12,000	7	5.6%	$2,500
Scale	$ 7,000	20	5.6%	$1,000
Front End Loader	$ 15,000	7	5.6%	$3,000
Grinders & Conveyors	$127,000	10	4.2%	$4,000



HEIL GONDARD MILL LAYOUT SCHEMATIC

DIVISION OF ENGINEERING
DEPARTMENT OF PUBLIC WORKS
CITY OF MADISON, WISCONSIN

D.G.H. 1/15/68



GPO 942448

SECTION A-A
OF HEIL GONDARD MILL LAYOUT SCHEMATIC

DIVISION OF ENGINEERING
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